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June 1997

Science 30

Grade 12 Diploma Examination

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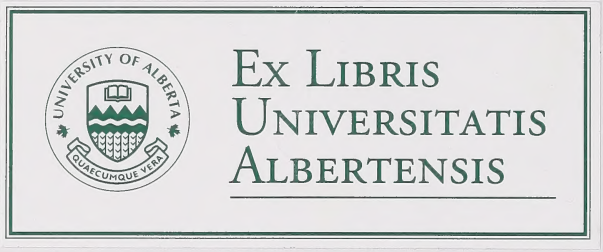

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June 1997

Science 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions of equal value, worth 70% of the examination
- 2 written-response questions, each worth 15% of the examination

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

A science data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. science
B. biology
C. physics
D. chemistry

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

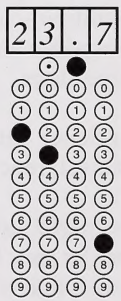
Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.
(Record your answer to three digits on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666
= 23.7 (rounded to three digits)

Record 23.7 on the answer sheet →



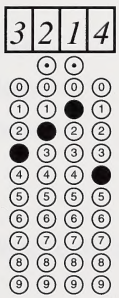
Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____. (Record all four digits on the answer sheet.)

1 physics
2 chemistry
3 biology
4 science

Answer 3214

Record 3214 on the answer sheet →



Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

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Perhaps the most convenient form of energy for domestic use is electrical energy distributed by regional power grids. Depending on the region, the grids may collect electrical energy from power sources such as wind turbines, photovoltaic cells, hydroelectric dams, or coal-fired thermal plants.

1. The **ultimate** (original) source of energy for all the generating methods listed above is

A. gravity
B. photosynthesis
C. fusion reactions
D. fission reactions

2. Earth's **primary** source of energy is

A. tidal
B. solar
C. geothermal
D. gravitational

Numerical Response

1. At a coal-burning power plant, anthracite coal, $C_{52}H_{16}O_{(s)}$, undergoes combustion according to the following equation:

$$C_{52}H_{16}O_{(s)} + \tfrac{111}{2}O_{2(g)} \rightarrow 52\,CO_{2(g)} + 8\,H_2O_{(g)}$$

The molar heat of formation (ΔH_f°) for anthracite coal is +21 250 kJ/mol. Use this value to determine the amount of energy produced from burning one mole of coal.

$\Delta H_r = -$_____ ___•___ _____ _____ $\times 10^4$ kJ

(Record your answer to three digits on the answer sheet.)

Use the following information to answer the next question.

The burning of fossil fuels is a major cause of acid rain. The stronger the acid formed, the more damaging its effect. Four acids associated with fossil fuel combustion are

I $H_2CO_{3(aq)}$
II $HNO_{3(aq)}$
III $HNO_{2(aq)}$
IV $H_2SO_{3(aq)}$

3. The strongest acid listed is

A. I
B. II
C. III
D. IV

Use the following information to answer the next question.

Reaction Between $HNO_{2(aq)}$ and $NaOH_{(aq)}$

$$HNO_{2(aq)} + OH^-_{(aq)} \rightleftharpoons NO_2^-{}_{(aq)} + H_2O_{(l)}$$

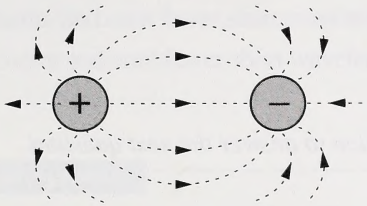
4. The Brønsted–Lowry bases in this equation are

A. $H_2O_{(l)}$ and $OH^-_{(aq)}$
B. $NO_2^-{}_{(aq)}$ and $H_2O_{(l)}$
C. $OH^-_{(aq)}$ and $NO_2^-{}_{(aq)}$
D. $HNO_{2(aq)}$ and $NO_2^-{}_{(aq)}$

Use the following information to answer the next question.

Several Fields and One Energy Source Present at a Power Plant

1.



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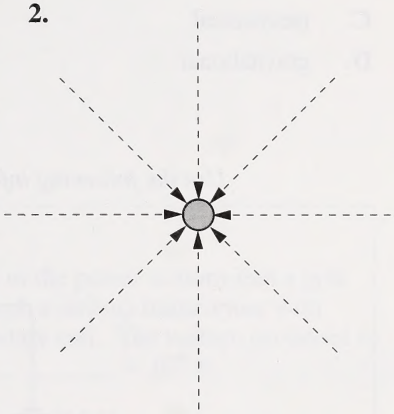

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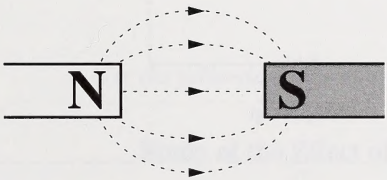

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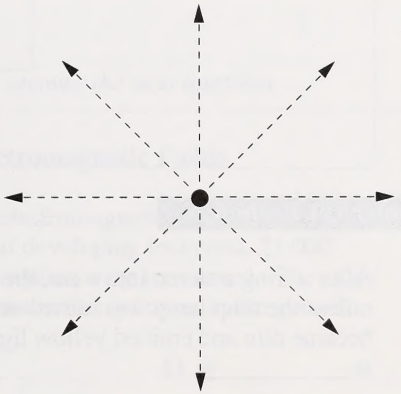


Numerical Response

2. Match the diagrams above with the following items found in a power plant.

Electric motors (magnetic) _____ (Record in column 1 on the answer sheet.)

Photocopier (electrostatic) _____ (Record in column 2 on the answer sheet.)

Lamp light (light) _____ (Record in column 3 on the answer sheet.)

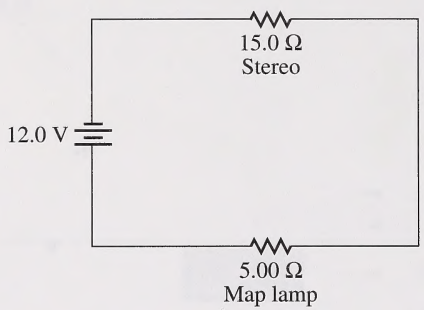
Hydroelectric dam (gravitational) _____ (Record in column 4 on the answer sheet.)

5. A force field **cannot** be

A. magnetic
B. electrical
C. mechanical
D. gravitational

Use the following information to answer the next question.

A Car Circuit



Numerical Response

3. After wiring a stereo into a car, the installer noticed that the stereo would not work unless the map lamp was turned on. When the stereo was turned on, the lamp became dim and emitted yellow light. The total resistance in this car circuit is _____ Ω.

(Record your answer to three digits on the answer sheet.)

6. By comparison with the filaments of a bulb producing white light, the filaments of a bulb producing yellow light are

A. hotter and emit more short wavelengths

B. cooler and emit more short wavelengths

C. hotter and emit fewer short wavelengths

D. cooler and emit fewer short wavelengths

Numerical Response

4. To distribute the electricity produced from one of the power stations into a grid, electricity from a 240 V generator passes through a step-up transformer with a 155-turn primary coil and a 7 500-turn secondary coil. The voltage produced by the transformer is _____ _____ _____ _____ $\times 10^4$ V.

(Record your answer to three digits on the answer sheet.)

Use the following information to answer the next question.

Study of the Effect of Electromagnetic Fields

To investigate the concern that exposure to electromagnetic fields produced by high-voltage power lines increases the risk of developing leukemia, 23 000 utility workers from different geographical regions were monitored. The study revealed about the same incidence of leukemia in this group as in the general population.

7. The responding (dependent) variable in the study is the

A. electromagnetic field

B. incidence of leukemia

C. number of workers studied

D. geographical location of the workers

Use the following information to answer the next question.

Energy Sources

1 Coal
2 Propane
3 Natural Gas
4 Tidal Energy
5 Solar Energy
6 Wind Energy
7 Fission Reactions
8 Hydroelectric Energy

Numerical Response

5. The four renewable energy sources, listed in any order, are _____, _____, _____, _____.

(Record all **four** digits on the answer sheet.)

Use the following information to answer the next question.

Factors Affecting Development of Energy Resources

Resource		Rating*			
		Renewability	Availability	Environmental Impact	Cost**
1	Hydroelectric	4	3	4	8
2	Coal-fired thermal	1	9	2	10
3	Solar	5	2	9	1
4	Tidal	5	2	8	3

* Ratings are from 1 and 10, where 1 is least favourable and 10 is most favourable.

** Cost rating is based on installation as well as maintenance.

Note: These ratings were estimated for this situation only.

Numerical Response

6. Assume that the four rating categories (renewability, availability, environmental impact, and cost) are given equal weight. Based on **all** the ratings, resources 1, 2, 3, and 4 ranked from **most to least** favourable are

_____, _____, _____, _____.
most favourable — least favourable

(Record all **four** digits on the answer sheet.)

Use the following information to answer the next question.

Possible Characteristics of Electrical Energy Generating Methods

I	Uses non-renewable fuel
II	Contributes to acid rain
III	Heats up water
IV	Converts chemical potential energy
V	Converts gravitational potential energy
VI	Is not available during all seasons

8. Tidal energy includes which of the above characteristics?

A. V only
B. VI only
C. I and V only
D. II and VI only

---

9. Three Canadian provinces use electricity generated by CANDU reactors. CANDU reactors produce heat through

A. phase changes
B. fusion reactions
C. fission reactions
D. chemical reactions

Numerical Response

7. A CANDU reactor produces 2.0×10^9 J of energy every second. The amount of mass being converted to energy during this time is _____ _____ • _____ _____ $\times 10^{-8}$ kg.

(Record your answer to two digits on the answer sheet.)

10. The heat produced in the core of a CANDU reactor is absorbed by a coolant that is pumped into generators where water is turned into steam and directed through pipes to the turbine. Which of the following methods would **best** minimize heat losses from the pipes?

A. Insulating the pipes
B. Using steam at a higher pressure
C. Making the steam generator smaller
D. Using supplemental gas heat to increase the temperature of the steam

11. A nuclear generating station converts energy from

A. solar to nuclear to mechanical to electrical
B. nuclear to chemical to thermal to electrical
C. nuclear to thermal to mechanical to electrical
D. chemical to thermal to mechanical to electrical

12. When comparing the way energy is produced in the CANDU reactor with the way it is produced in the Sun, a major difference is that uranium nuclei are

A. split in the reactor and hydrogen nuclei are split in the Sun
B. fused in the reactor and hydrogen nuclei are split in the Sun
C. split in the reactor and hydrogen nuclei are fused in the Sun
D. fused in the reactor and hydrogen nuclei are fused in the Sun

13. The pH of the water in a steam generator needs to be monitored because of the possible effect of acidic conditions on the generator walls. Acidic conditions could result in

A. corrosion
B. combustion
C. neutralization
D. acid deposition

Numerical Response

8. If the hydronium ion concentration, $[H_3O^+_{(aq)}]$, of the water in a steam generator is 2.8×10^{-5} mol/L, the pH is _____ _____ _____ _____

(Record your answer to three digits on the answer sheet.)

14. A risk associated with nuclear reactors involves exposure to radiation. EMR from radioactive sources can cause damage to cells. Compared with visible light, this type of radiation would have

A. less energy and a longer wavelength
B. less energy and a shorter wavelength
C. more energy and a longer wavelength
D. more energy and a shorter wavelength

15. A reactor leak could expose human cells to damaging radiation. If one base in the structure of a DNA molecule was altered by ionizing radiation, it would be called

A. nondisjunction
B. a point mutation
C. recombinant DNA
D. a chromosomal aberration

16. The testing of radioactive water samples on living cells can cause changes to the cell's DNA. The separation of DNA that occurs **normally** during replication is between

A. base pairs

B. atoms within base molecules

C. the sugar and phosphate of side strands

D. bases and sugar-phosphate side strands

Use the following information to answer the next question.

Ionization of Water by Radiation

$$\text{Radiation} + 2\,H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$$

17. Water molecules may be ionized (dissociated) by radiation. On the basis of the equation above, the effect of radiation on water molecules is to

A. increase the pH by increasing $H_3O^+_{(aq)}$ concentration

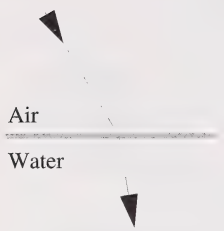
B. decrease the pH by increasing $H_3O^+_{(aq)}$ concentration

C. maintain a constant pH because both a proton acceptor and proton donor are produced

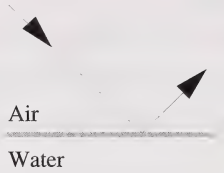
D. maintain a constant pH because neither a proton acceptor nor a proton donor are produced

18. Which of the following diagrams **best** demonstrates the phenomenon of refraction?

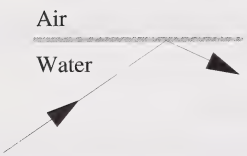
A.



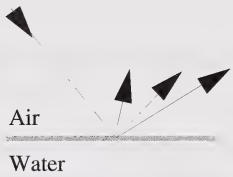
B.



C.



D.



Participation in athletics places physiological demands on an athlete's body, especially the cardiovascular system.

19. Various mechanisms operate to regulate cardiac function. Which of the following series of steps represents the body's response to an increase in exercise?

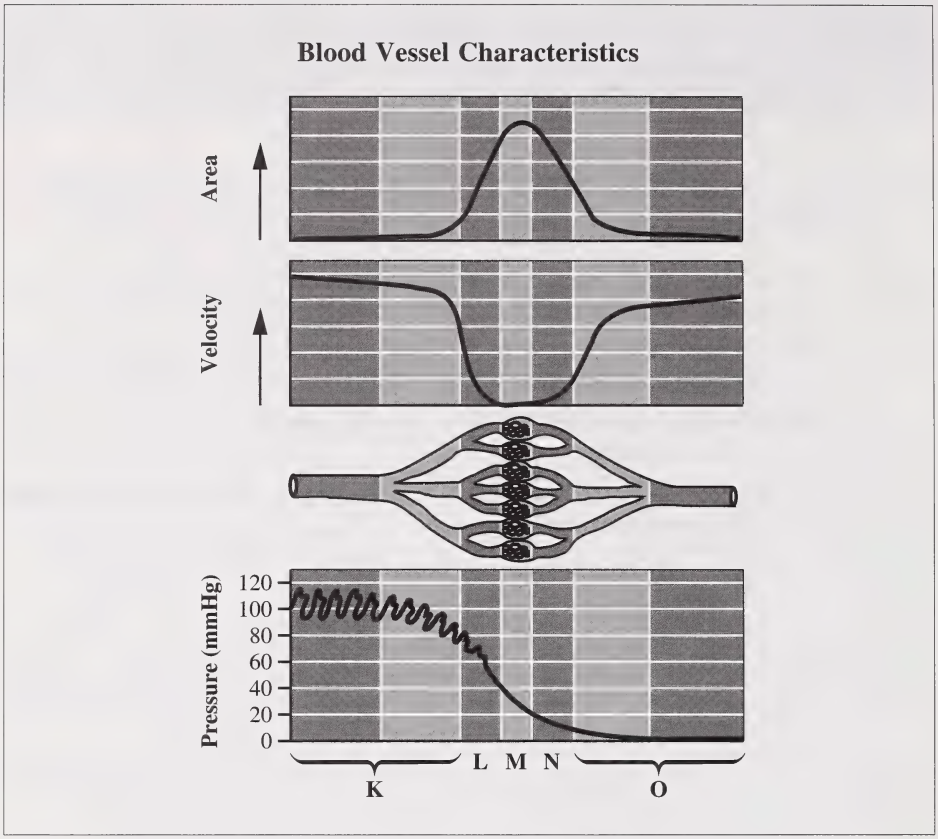
A. Blood return to the heart increases → sympathetic nerve activity increases → cardiac output increases

B. Blood return to the heart increases → sympathetic nerve activity increases → cardiac output decreases

C. Blood return to the heart decreases → sympathetic nerve activity increases → cardiac output increases

D. Blood return to the heart decreases → sympathetic nerve activity decreases → cardiac output decreases

Use the following information to answer the next question.



20. The sequence K, L, M, N, O represents, respectively, the blood vessels

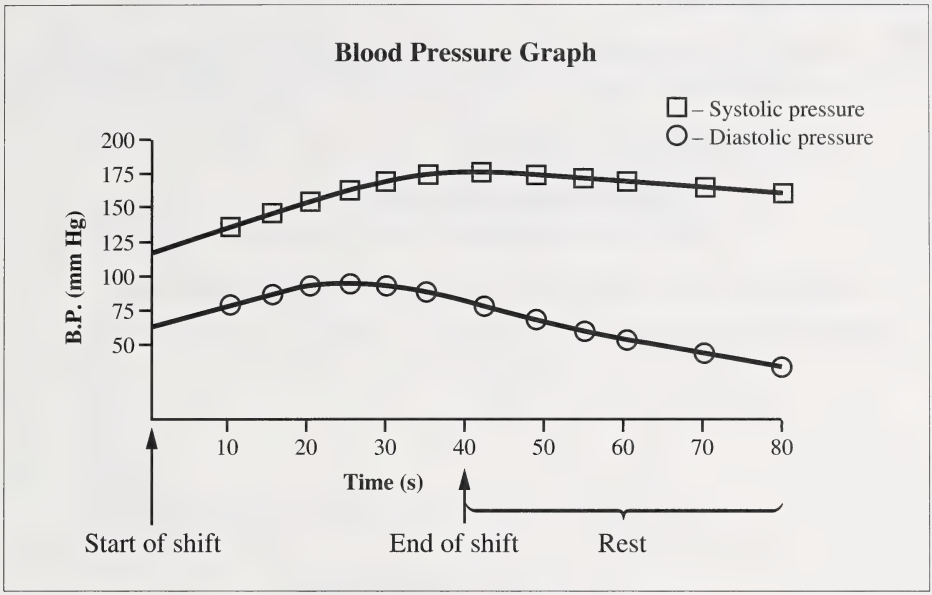
A. vein, venule, capillary, arteriole, artery

B. artery, arteriole, capillary, venule, vein

C. arteriole, artery, capillary, vein, venule

D. artery, venule, capillary, arteriole, vein

Use the following information to answer the next question.



21. Near the end of a game, a hockey player played in shifts of about 40 s. The graph represents blood pressure measurements for this player. During exercise,

A. systolic pressure increased because the ventricles contracted more forcibly

B. diastolic pressure decreased because the ventricles contracted more forcibly

C. systolic pressure decreased because the ventricles relaxed, allowing greater blood flow

D. diastolic pressure increased because the ventricles relaxed, allowing more blood to leave the heart

Numerical Response

9. In hockey, a flashing red light indicates that a goal has been scored. Possible physiological events that players experience when the light flashes are listed below.

1 Blood pressure increases
2 The retina is stimulated by the red light
3 The sympathetic nervous system is activated
4 The brain receives information sent by sensory neurons in the retina

List the four events in the order that the players would experience them.

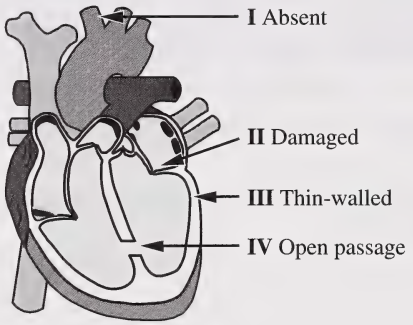
Answer: _____ , _____ , _____ , _____

(Record all **four** digits on the answer sheet.)

Use the following information to answer the next question.

Heart Abnormalities

The location and nature of some abnormalities are shown below.



22. The abnormality that would cause the **greatest decrease** in oxygen levels in arterial blood is labelled

A. I
B. II
C. III
D. IV

Use the following information to answer the next question.

Blood Components

I	Plasma
II	Platelets
III	Red blood cells
IV	White blood cells

23. Cuts are common in contact sports. The blood components that inhibit blood loss and combat the bacteria that enter the circulatory system through these cuts are labelled

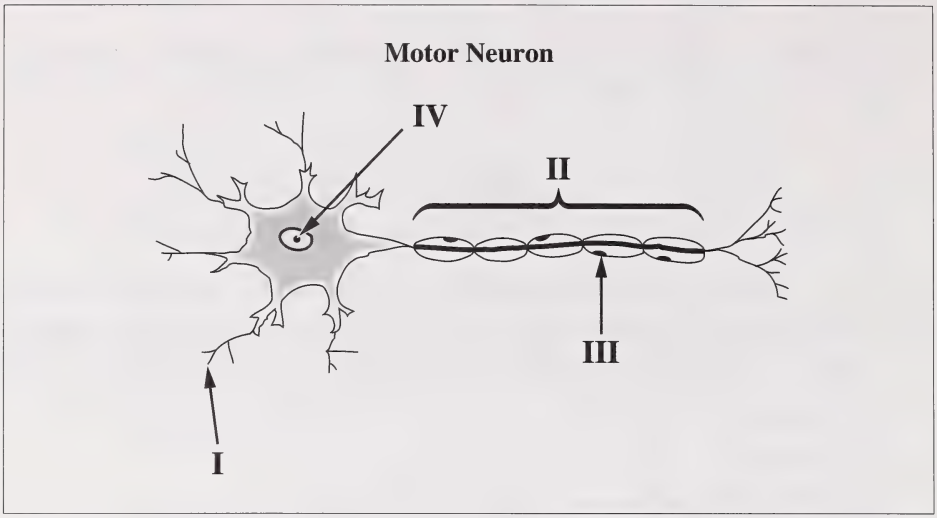
A. I and II

B. I and III

C. II and IV

D. III and IV

Use the following information to answer the next question.



24. Skills in athletics are dependent upon nervous system responses. A dendrite is represented by the structure labelled

A. I

B. II

C. III

D. IV

Numerical Response

10. A motor neuron had an effective potential difference of 70.0 mV. The influx of sodium ions generated a current of 3.60 mA. The effective resistance of the neural membrane was _____ Ω.

(Record your answer to three digits on the answer sheet.)

The production of pollution is one of the risks associated with industrialization. It is important to monitor the levels of pollution, know the effects of pollution, and be able to reduce or eliminate pollution wherever possible.

25. As scientists began to understand the effects of pollutants on living systems, they developed a vocabulary to explain these effects. One such term is biomagnification. This term refers to the

A. rapid growth of an organism
B. rapid increase in the population of an organism
C. increase in the concentration of a pollutant in producers
D. increase in the concentration of a pollutant in higher levels of the food chain

26. Skin cancer is being diagnosed more and more frequently as people are increasingly exposed to

A. infrared radiation caused by increasing ozone levels in the upper atmosphere
B. infrared radiations caused by decreasing ozone levels in the upper atmosphere
C. ultraviolet radiation caused by increasing ozone levels in the upper atmosphere
D. ultraviolet radiation caused by decreasing ozone levels in the upper atmosphere

27. A biologist suspects that the pH of a lake is below 3.8. Which indicator could be used to confirm the biologist's suspicion?

A. Litmus
B. Phenol red
C. Methyl orange
D. Bromothymol blue

Use the following information to answer the next question.

Environmental Chemicals

1 CFCs
2 $CO_{2(g)}$
3 $SO_{2(g)}$
4 PCBs

Numerical Response

11. Using each number once, match the chemical **most likely** to cause each of the following environmental concerns.

Acid rain _____ (Record in column 1 on the answer sheet.)
Ozone depletion _____ (Record in column 2 on the answer sheet.)
Biomagnification _____ (Record in column 3 on the answer sheet.)
Greenhouse Effect _____ (Record in column 4 on the answer sheet.)

---

28. In recent years, much has been done to reduce the production of dioxins and furans. However, one remaining source of them is

A. coal mining
B. sour gas wells
C. automobile exhaust
D. pulp and paper production

Use the following information to answer the next question.

Chemical Compounds

I $CH_3-\overset{\overset{O}{\|}}{C}-O-CH_3$

II $CH_3-\overset{\overset{O}{\|}}{C}-H$

III CH_3-OH

IV $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

29. The structural formula that represents the compound methanol is

A. I
B. II
C. III
D. IV

---

30. Hazardous substances must be clearly marked, indicating both the content and nature of the hazard for each substance. Which WHMIS symbol should accompany a concentrated solution of $NaOH_{(aq)}$?

A.

B.

C.

D.

Medical practitioners must understand principles of research, body systems, and physics involved in the technology they use.

Use the following information to answer the next question.

Scientists are perplexed because some people infected with HIV (Human Immune Deficiency Virus) develop AIDS within five years, while other people remain free of symptoms after ten years. To explain the differences between these two groups of people, scientists are testing the hypothesis that the groups are genetically different.

31. To test the hypothesis, the scientists should compare the two groups of people with respect to their

A. diet and activities

B. parents and siblings

C. ages and nationalities

D. exposure to toxins in the environment

---

32. The AIDS virus attacks a crucial variety of helper T cells. These helper T cells are a type of

A. platelet

B. plasma cell

C. red blood cell

D. white blood cell

33. Healthy people have about 1 000 helper T cells per millilitre of blood. People with AIDS may have around 200 helper T cells per millilitre of blood. The direct effect of this would likely be an increased risk of

A. infections

B. hemophilia

C. phenylketonuria

D. high blood pressure

Use the following information to answer the next question.

Structures Studied in Genetics

1 DNA

2 Genes

3 Chromosomes

4 Diploid (2n) cells

Numerical Response

12. Use the numbers from the structures listed above to complete these statements. Use each number only once.

Units of inheritance are called _____. (Record in column 1 on the answer sheet.)

The sequence of bases in _____ determines protein structure. (Record in column 2 on the answer sheet.)

_____ are formed upon fertilization. (Record in column 3 on the answer sheet.)

Nondisjunction of _____ produces abnormalities. (Record in column 4 on the answer sheet.)

34. In 1796, Edward Jenner noticed that people who had previously contracted cowpox were not infected with smallpox, a similar but more serious disease. Jenner vaccinated other individuals with a small dose of the cowpox virus, thus making them immune to smallpox infection. The procedure worked because

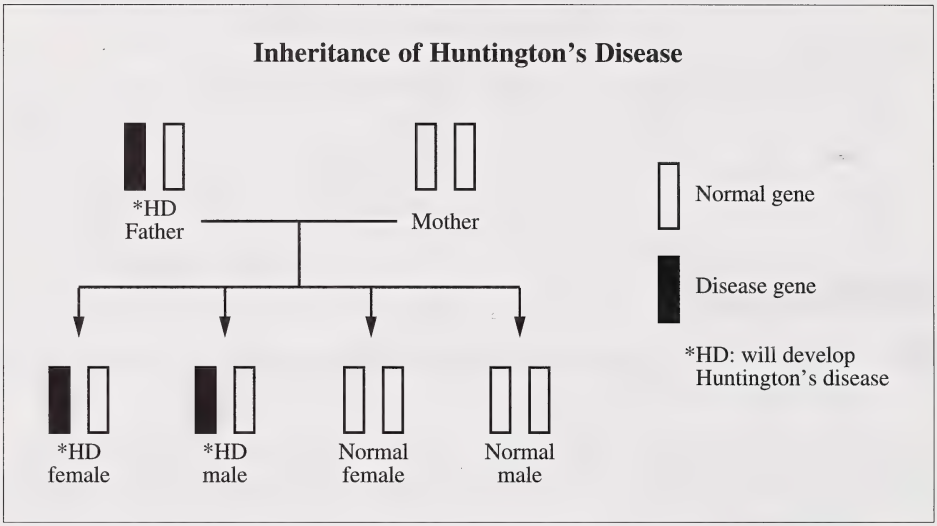
A. the cowpox virus was recessive to the smallpox virus

B. the smallpox virus was recessive to the cowpox virus

C. killer T cells were formed when the related cowpox virus was introduced

D. memory cells were formed when the related cowpox virus was introduced

Use the following information to answer the next question.



35. A heterozygous father with Huntington's disease and a normal mother have a child. The probability of the child developing Huntington's disease is

A. 25%

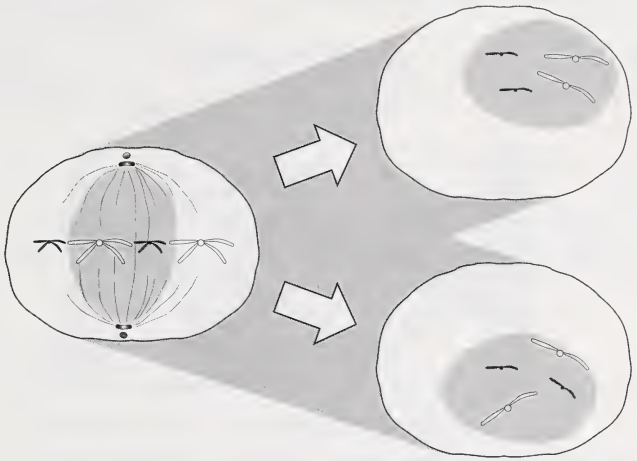
B. 50%

C. 75%

D. 100%

Use the following information to answer the next question.

Cell Process



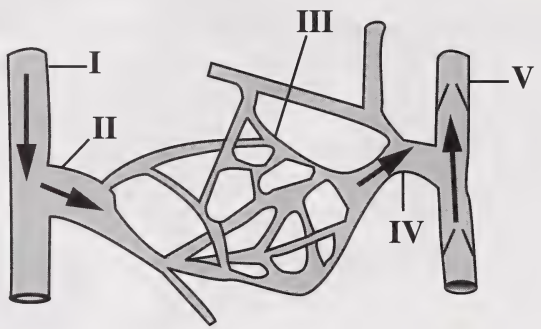
36. The process represented by the diagram is

A. mitosis
B. meiosis
C. fertilization
D. nondisjunction

Use the following information to answer the next question.

Port-wine stains are pink birthmarks on the skin that tend to darken with age. They are caused by the malformation of capillaries and venules.

Blood Vessels



Arrows indicate the direction of blood flow.

37. Capillaries and venules are represented by structures

A. I and II
B. II and IV
C. III and IV
D. III and V

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38. Argon lasers that emit electromagnetic radiation with a wavelength of 514 nm are used to lighten port-wine stain birthmarks. The region of the electromagnetic spectrum that corresponds to a wavelength of 514 nm is the

A. X-ray region
B. visible region
C. infrared region
D. microwave region

39. A laser beam slows down as it passes from the air into the skin. If the frequency stays the same, there must be

A. an increase in wavelength

B. a decrease in wavelength

C. an increase in the number of waves per second

D. a decrease in the number of waves per second

40. When malformed venules and capillaries are irradiated, the hemoglobin in them absorbs the radiation emitted by the laser. This **most closely** resembles what happens when

A. ultraviolet radiation strikes ozone

B. NO_X is produced by internal combustion engines

C. stars emit different colours at different temperatures

D. gases are heated and produce a line-emission spectrum

A space lab was launched for the purpose of studying various astronomical phenomena.

41. The communication devices used by the astronauts operated on a frequency of 4.91×10^7 Hz. The wavelength corresponding to this frequency is

A. 0.164 m
B. 6.11 m
C. 14.7 m
D. 100 m

42. An astronomer observed a star that demonstrated redshift. The wavelength of the light emitted by the star appeared to have

A. decreased because the star was moving away from the lab
B. increased because the star was moving away from the lab
C. decreased because the star was moving toward the lab
D. increased because the star was moving toward the lab

43. The radiation emitted by the hottest stars consists mostly of

A. X-rays and gamma rays
B. infrared rays and radio waves
C. visible light and ultraviolet light
D. ultraviolet light and infrared rays

44. A physicist on the space lab estimated the mass of a small asteroid to be 5.00×10^{16} kg and the radius to be 6.38×10^3 m. The gravitational force on a 1.00 kg test mass on the asteroid's surface would be

A. 8.19×10^{-2} N
B. 1.91×10^{-1} N
C. 1.22 N
D. 5.23×10^2 N

For the written-response questions, use complete sentences.
Use tables, graphs, and diagrams where appropriate.

Written Response – 15% (12 marks)

1. In Alberta, alfalfa plants are an important crop used as animal feed and to replenish nitrogen compounds in soils. These plants, however, are sensitive to changes in soil pH. Farmers need to know the effects of acid deposition on alfalfa plants in order to maximize crop yields.

Design an experiment to determine the effect of acid deposition on alfalfa plants.

Organize your experimental design under the following headings:
purpose, hypothesis, variables, procedure, and data table.

Purpose .....

.....

Hypothesis .....

.....

Variables Identify the manipulated (independent), the responding (dependent), and three controlled variables.

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Question 1 is continued on the next page.

Procedure Write a procedure to test your hypothesis. Ensure that the procedure is detailed enough for someone else to follow.

Data Table Design a table or tables to record the data you would collect during the course of the experiment. The table or tables should be consistent with the procedure you designed.

Turn the page to begin the next question.

Written Response – 15% (12 marks)

2. In his book, *Inventing the Future*, David Suzuki discusses the issues of **human population growth**, the **use of non-renewable resources**, and **pollution**. He writes:

> *Within the lifetimes of our children, the entire future of our species will have been decided. The curves now going straight up will have to level out and turn downward. If we don't do it deliberately, Nature will impose the final control.*

Explain the meaning of David Suzuki's statement in relation to the three issues above. Outline your point of view on the issues presented in the statement and support your arguments with specific examples. Include a description of the role of science, technology, and society in resolving these issues.

You have now completed the examination.
If you have time, you may wish to check your answers.

No marks will be given for work done on this page.

Fold and tear along perforation.

No marks will be given for work done on this page.

Fold and tear along perforation.

No marks will be given for work done on this page.

Fold and tear along perforation.

Credit

Page 32 David Suzuki. From *Inventing the Future: Reflections on Science, Technology and Nature* (Stoddart Publishing, 1991). Reprinted under the Alberta Government Print Licence with CanCopy (Canadian Copyright Licensing Agency).

No marks will be given for work done on this page.

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